

The mammalian fauna of Greater Melbourne: diversity, loss, adaptation and change

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Abstract

We collated and analysed records of mammal species (native and introduced) from across 32 Local Government Areas that comprise the Greater Melbourne region. Records of each species were examined for temporal changes in presence or absence. The region has a particularly diverse mammalian fauna with records of 92 species, including 19 marine mammals that have been recorded in Port Phillip. This total represents 65% of Victoria's mammalian fauna. About one-third of the 51 native terrestrial species have undergone a demonstrable decline in the region, to the point where their future presence is in doubt. Five species are no longer found in the region and the status of another three is uncertain. In contrast, up to five native terrestrial species are thought to have increased in abundance in recent decades, including the spectacular colonisation of the city by the Grey-headed Flying-fox as a year-round resident. (*The Victorian Naturalist* 128 (5) 2011, 233–248)

Keywords: urban mammals; historical change; declining mammals; colonisation; adaptation

Introduction

Melbourne is a young city, having begun life 176 years ago, in 1835, and it was officially declared a city by Queen Victoria in 1847. Melbourne's population grew rapidly, reaching 29 000 by 1851 and 125 000 ten years later, after the gold rush of the 1850s (Dingle 1984). Melbourne is now a very large city of over 4 million people. As defined here it includes 32 Local Government Areas (LGAs) which total over 8800 km². Urbanised areas cover about 4000 km² (Fig. 1).

The Greater Melbourne region includes diverse environments, straddling parts of five of Victoria's terrestrial biogeographic regions—the Victorian Volcanic Plain, Otway Plain, Gippsland Plain, Central Victorian Uplands and Highlands–Southern Fall, and one marine region, Victoria's Embayments bioregion. The climate is Mediterranean, with hot, dry summers and cool moist winters, though rain can be expected in all months. There is, however, a strong rainfall gradient from west to east across the Greater Melbourne region, with the mean annual rainfall varying from about 400 mm on the Victorian Volcanic Plain in the west to more than 1300 mm at the Upper Yarra Dam in the Highlands–Southern Fall bioregion.

Within the urban areas are many parks and private house gardens which provide a mixture of indigenous and non-indigenous trees and shrubs. Non-indigenous plantings predominate,

many being of European origin, or from northern or western Australia. These non-indigenous plantings have altered the seasonal pattern of food production for frugivorous, nectarivorous and insectivorous species, providing a greater variety of food than the original vegetation communities (for example see Williams *et al.* 2006). This has had both positive and negative effects on indigenous mammals. There are also large areas of native vegetation, degraded to varying degrees, including a corridor extending for over 50 km along the Yarra River, culminating in the inner city Yarra Bend bushland. Outer national parks such as Dandenong Ranges, Churchill, Organ Pipes, Yarra Ranges, Mornington Peninsula and Point Nepean National Parks, Bunyip State Park and the Port Phillip Heads Marine National Park provide extensive areas of higher quality habitat.

Fauna surveys in the Melbourne region began in 1855 with expeditions by the first Government Zoologist, Wilhelm Blandowski, to the Yarra Ranges and Mornington Peninsula (Blandowski 1856; Menkhorst 2009). Over 100 years passed before further comprehensive mammal surveys were undertaken in the area (as distinct from the opportunistic collection of specimen records), mostly by amateur mammal survey groups (e.g. Callanan and Gibson 1977; Seebeck 1977; Hampton *et al.* 1982). The Vic-

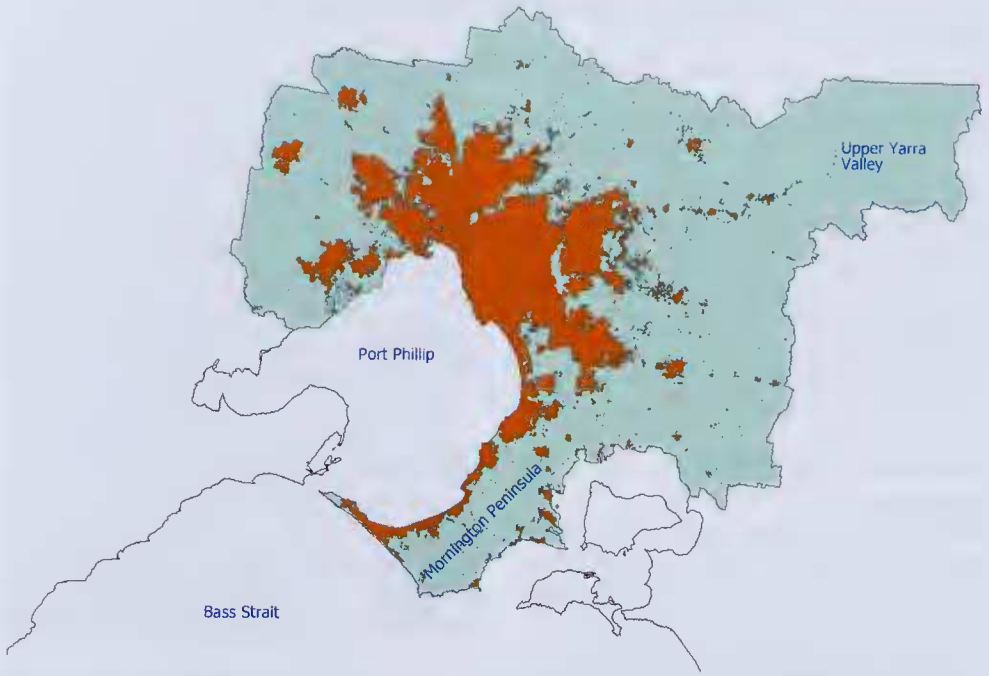


Fig. 1. Map showing the Greater Melbourne area (green shading) and the urbanised parts of Greater Melbourne (red shading).

torian Government initiated systematic fauna surveys under the auspices of the Land Conservation Council of Victoria between 1970 and 1995 (Clode 2006) and these provide a major source of records used in this paper (for example, Lumsden *et al.* 1991).

Methods

Greater Melbourne is here defined as extending from the Shire of Wyndham in the west around the hinterland of Port Phillip to include the Shires of Yarra Valley, Mornington Peninsula and Cardinia (Fig. 1).

The Victorian Biodiversity Atlas (VBA, formerly Atlas of Victorian Wildlife) is a computer database maintained by the Department of Sustainability and Environment that contains locality records of mammals in Victoria from the earliest phases of European occupation until the present day. It includes vetted records derived from Government fauna surveys, researchers, Museum specimen catalogues, the

literature, and those submitted by members of the public (Menkhorst 1995a Appendix 1).

For completeness, introduced species that have formed wild populations, and marine mammals that have been recorded in Port Phillip are also considered part of the fauna of Greater Melbourne. To discern changes to the mammalian fauna of the Melbourne region, and to describe the mammal communities that persist in both the total region and in the urbanised parts of Melbourne, VBA records from Greater Melbourne and the smaller urban area were extracted in September 2010 and summarised as the number of records per species, and year of last record of each species. This information was supplemented by a review of the literature pertaining to mammals in the Melbourne area (e.g. Blandowski 1856; Callanan and Gibson 1977; Seebeck 1977, 1984, Ambrose 1979; Hampton *et al.* 1982; Brown and Horrocks 1988; Lumsden *et al.* 1991; van der Ree 2004) and to ecological studies of particular species.

The opportunistic observations of both authors over more than 40 years of living in Melbourne were also drawn upon where appropriate.

The number of VBA records of each species in the total area and the urbanised subset of Greater Melbourne were tabulated, along with the year of last record for each species in each area (Appendix 1). These data were then examined to investigate the attrition of species from the Melbourne region within three broad time periods, pre-1900, 1900–1949 and 1950–1999. For the purposes of this study, species recorded since 2000 are considered to be still extant in the region.

Results

The VBA contained 33 939 records of 70 species of terrestrial mammal and 258 records of 19 species of marine mammal (Appendix 1). Records from within the urbanised part of Greater Melbourne totalled 5687 (16.7% of all records of terrestrial species) (marine mammals were classified as non-urban species even though Australian Fur Seals and Burrunan dolphins are occasionally recorded in the Yarra River estuary), and 62 species were represented (Appendix 1). Based on known occurrences nearby, and their ecological requirements, three other species are considered likely to have inhabited the study area in historical times—Long-nosed Potoroo *Potorous tridactylus*, White-footed Rabbit Rat *Conilurus albipes* and Long-eared Rat *Pseudomys auritus*. Conversely, new species are still being added to the list as distributions change or more intensive surveys and new survey techniques lead to increased detection probabilities. For example, the species diversity of insectivorous bats that are found in suburban Melbourne is higher than previously understood, and the successful occupation of Melbourne by the Grey-headed Flying-fox *Pteropus poliocephalus* may well be followed by the Black Flying-fox *Pteropus alecto* which is also extending its range southward and was found for the first time in Melbourne in very small numbers in July 2010.

Table 1 provides a breakdown of these 92 species (70 terrestrial, 19 marine plus 3 likely to have occurred) into the major taxonomic groups represented. The 12 most commonly reported species across the entire area and within

the urban area are listed in Table 2. Note however that the rank orders may not accurately reflect abundance—in the case of mammals several anthropogenic factors such as ease of detection, public interest, and perceived pest status strongly influence people's motivation to report sightings.

Species which have changed in abundance over time

Species whose abundance has clearly changed over time are discussed below, grouped into three broad periods to assist analysis—pre 1900, 1900–1949 and 1950–1999. Species which have been recorded after 1999 are assumed to be still present in 2011. The VBA contains few records of common forest species in the last decade from forests on the urban fringe, and in most cases we believe this reflects a lack of formal surveys, rather than an actual decline.

Species which have declined Pre 1900

There is reason to believe that three species may have become regionally extinct before 1900:

Southern Bettong *Bettongia gaimardi*

The Southern Bettong is listed as being sighted by members of the Field Naturalists Club of Victoria while on an expedition from Healesville to the upper reaches of the Yarra River (specifically to the Yarra Falls at approximately 37° 45' S, 146° 06' N) (Anon 1891, as *Hypsiprimmus cuniculatus*). This record is somewhat perplexing because the dominant habitat through which the expedition travelled seems atypical for this species—tall, dense and wet forest, whereas in Tasmania, where it remains common, the Southern Bettong prefers drier, grassy forests on poor soils (Rose and Johnson 2008). However, the species may have occupied drier, grassy forest on ridgelines in the Yarra Ranges (where dry-forest birds such as Scarlet Robin *Petroica boodang* and Spotted Quail-thrush *Cinlosoma punctata* still persist). At the time of European occupation, the Southern Bettong was probably widespread in grassy open-forest across southern and central Victoria (Seebeck 1995a), but there are no records from the 20th century.

White-footed Rabbit Rat *Conilurus albipes*

Apparently widespread in open forest and woodland across much of south-eastern Aus-

Table 1. Number of species of indigenous and introduced mammals in the major taxonomic groupings represented in the Greater Melbourne region.

Group	Indigenous	Introduced	Total
Monotremes	2		2
Polyprotodont marsupials	12		12
Diprotodont marsupials	16		16
Flying-foxes	3		3
Insectivorous bats	17		17
Rodents	8	4	12
Seals	6		6
Eutherian land carnivores		4	4
Ungulates		5	5
Lagomorphs		2	2
Cetaceans	13		13
Totals	77	15	92

Table 2. The 12 most commonly reported mammal species in the Victorian Biodiversity Atlas database from Greater Melbourne (A) and in the Melbourne urban area (B).

A. Greater Melbourne		B. Melbourne urban areas	
Rank	Species	Rank	Species
1	Common Ringtail Possum	1	Grey-headed Flying-fox
2	Koala	2	Common Brushtail Possum
3	Common Brushtail Possum	3	Common Ringtail Possum
4	European Rabbit	4	Red Fox
5	Eastern Grey Kangaroo	5	European Rabbit
6	Bush Rat	6	House Mouse
7	Red Fox	7	Eastern Grey Kangaroo
8	Agile Antechinus	8	Black Rat
9	Black Wallaby	9	Platypus
10	Grey-headed Flying-fox	10	Sugar Glider
11	Sugar Glider	11	Koala
12	House Mouse	12	Short-beaked Echidna

tralia at the time of European occupation, the White-footed Rabbit Rat was well-known to rural people during the 1840s and 1850s (Seebeck and Menkhorst 2000; Menkhorst 2009) but declined to extinction extremely rapidly, with the last specimens being collected in 1862 (Williams and Menkhorst 1995).

Long-eared Rat *Pseudomys auritus*

The Long-eared Rat has only recently been reassessed as a full species (G. Medlin pers. comm), having previously been considered to be conspecific with the widespread, arid-country Plains Mouse *Pseudomys australis*. Abundant sub-fossil material (Wakefield 1964, 1974 as *Pseudomys sp*) and the observations of George Augustus Robinson during 1841 (quoted by Seebeck 1984a (as *Pseudomys australis*)) indicate that the Long-eared Rat was appar-

ently a common animal in grassland and open woodland in south-western Victoria until the early 1850s after which it rapidly disappeared (Medlin 2008). It is plausible, but not known with certainty, that the species occurred across the Victorian Volcanic Plain bioregion, including in the Werribee district.

1900–1949

Three native species declined precipitously during the first half of the 20th century:

Eastern Quoll *Dasyurus viverrinus*

The Eastern Quoll was once very common across much of Victoria (Seebeck 1984a; Menkhorst 1995b) but steadily declined through the first half of the 20th century. The last recorded Victorian individuals survived in dense riparian scrub and rock outcrops along the Yarra River

and its tributary Darebin Creek in the Melbourne suburbs of Kew, Darebin and Fairfield until the 1950s (Menkhorst 1995b). This is the only Victorian mammal species known to have survived longer in an urban environment than in the surrounding less urbanised areas, presumably protected by the intervening suburbs from the threats that were driving it to extinction in rural Victoria, such as hunting and poisoning, fox predation and disease (Menkhorst 1995b). A similar pattern of delayed decline within a suburban area took place in New South Wales where the last records of Eastern Quoll were in Nelson Park, Vacluse, Sydney in the early 1960s (Nelson 1968). A captive population derived from Tasmanian animals has been established behind fox-proof fences at Mt Rothwell near Little River, just outside the present study area.

Eastern Barred Bandicoot *Perameles gunnii*
Formerly widespread in the grasslands of the Victorian Volcanic Plain bioregion, records of the Eastern Barred Bandicoot from the eastern parts of its range, including from grasslands in the west of Melbourne, petered out in the 1950s (Menkhorst and Seebeck 1990; Seebeck 1995b). A remnant population in and around Hamilton has supplied stock for a captive-breeding and release program that has had limited success. Re-introduced populations in the Greater Melbourne area exist behind fox-proof fences at Mt Rothwell and at Woodlands Historic Park in Greenvale. The mainland population is genetically distinct from those in Tasmania, perhaps at the level of a subspecies (Robinson 1992).

Red-bellied Pademelon *Thylogale billardierii*
Although there is only one definite record from the study area, it seems likely that the Red-bellied Pademelon would have been widespread in dense scrub on the sandy coastal plains around Port Phillip—there is a Museum Victoria specimen labelled Werribee 1881 and it was apparently a common animal in other coastal localities including the Gippsland Lakes (Williams 1995). Based on the timing of its disappearance in other parts of Victoria, such as around the Gippsland Lakes, it is likely that the species was also lost from the Port Phillip region early in the 20th century.

1950–1999

The VBA contains few recent records in the Greater Melbourne area of common forest mammals including Agile Antechinus *Antechinus agilis*, Bush Rat *Rattus fuscipes*, Swamp Rat *R. lutreolus*, Greater Glider *Petauroides volans* and Yellow-bellied Glider *Petaurus australis*, and virtually no records of these species from urbanised areas. However, we know they can still be found quite commonly in extensive forests in the east of the study area (e.g. Dandenong Ranges, Yarra Ranges and Bunyip State Park).

The retreat of these forest species corresponds to the rapid expansion of suburban Melbourne into the forested hills to the east and north-east, particularly the Dandenong Ranges. Of the arboreal species, only the Common Brushtail Possum *Trichosurus vulpecula*, Common Ring-tail Possum *Pseudocheirus peregrinus*, Sugar Glider *Petaurus breviceps* and Koala *Phascolarctos cinereus* remain in suburban Melbourne.

The small, ground-dwelling mammals have also fared badly during this period—few species survive even low-intensity urbanisation. The Eastern Quoll, Long-nosed Bandicoot *Perameles nasuta* and Southern Brown Bandicoot *Isodon obesulus* all showed signs of resilience, remaining for some years in modified habitats such as suburban golf-courses and parks. However, for each of these species this apparent resilience was insufficient, and they were eventually lost from urbanised areas during this period. Small and vulnerable populations of the two bandicoots survive in areas of natural vegetation on the outskirts of Greater Melbourne, with larger, more resilient populations in forests in the east of the region.

Species lost from urbanised areas include all bar one (Water Rat *Hydromys chrysogaster*) of the eight species of indigenous rodent, and all of the eight species of carnivorous marsupial. Brush-tailed Phascogales *Phascogale tapoatafa* continue to inhabit dry forests in the Warrandyte to St Andrews area, even among houses in places where special attention is given to conserving native vegetation and limiting ownership of pet cats and dogs (e.g. Bend of Islands). Microchiroptera (insectivorous bats) seem more resilient, with up to 10 species still found within the Melbourne suburbs (Appendix 1).

The other major group of species lost from Greater Melbourne during this time was characteristic of coastal heathy vegetation communities, which were formerly widespread on the low-lying plains around Port Phillip, including the Mornington Peninsula. Such species include the Eastern Pygmy Possum *Cercartetus nanus*, White-footed Dunnart *Sminthopsis leucopus* and New Holland Mouse *Pseudomys novaehollandiae*. The New Holland Mouse now appears to be a definite recent loss from the Greater Melbourne region, having disappeared from Tyabb (where it was recorded in 1970–74), Cranbourne (1973–74) and Langwarrin (1975–83) (Wilson 1996), for reasons which remain unclear, but probably reflect a combination of inappropriate fire regime, predation and fragmentation of habitat. The pygmy-possum, dunnart and Swamp Antechinus *Antechinus minimus* are likely to persist in heathy forest in Bunyip State Park in the far east of the study area, but surveys are required to establish this.

A wild population of the introduced Eastern Grey Squirrel *Sciurus carolinensis* persisted for some decades in some eastern suburbs of Melbourne (Seebeck 1984b; Seebeck and Menkhorst 2000), the last records being from Ripponlea in the 1950s.

Species which have increased

Several species have defied the usual trend of decline, especially in recent decades, and flourished in the suburbs or semi-rural regions of Greater Melbourne.

Common Brushtail Possum *Trichosurus vulpecula*

The Common Brushtail Possum has benefited from the creation of exotic gardens in Melbourne, which provide a greater variety and seasonal availability of food than the original indigenous vegetation communities apparently did. Hence, higher population densities can be supported in Melbourne than in natural forest. Common Brushtails are also adaptable in the den sites that they can use; any lack of mature trees with natural hollows is compensated by the availability of suitable spaces in the roofs of buildings, or in artificial dens erected to provide alternatives to roof spaces. Despite seemingly high levels of road mortality, the species

persists across most of Greater Melbourne. The Common Brushtail Possum is regarded as a pest by a section of Melbourne's populace because of damage that it causes to ornamental shrubs and trees, and because those possums which den in the roofs of houses can cause damage and make unwanted noise. However, the only research into the magnitude of these problems found that almost twice as many respondents had positive attitudes towards the Common Brushtail Possum as negative attitudes (Whiting *et al.* 2010).

Common Ringtail Possum *Pseudocheirus peregrinus*

The Common Ringtail Possum has also benefited from gardens with tall, dense shrubs and is common and widespread across suburban Melbourne. Where there is a tall, dense shrub layer this species shelters in an arboreal drey it constructs from twigs and leaves. Where dense shrubs are absent it can persist by sheltering in tree hollows or, rarely, in roof spaces. Seebeck (1977) found that the Common Ringtail Possum had a more restricted distribution within Melbourne than that of the Common Brushtail Possum. Our casual observations suggest that this may no longer be so, and that the Common Ringtail population in Greater Melbourne may now be greater than that of the Common Brushtail. However, Common Ringtail Possums suffer from hyperthermia and dehydration during days of extreme heat, and many did not survive the hot spell in early February 2009, which culminated in the Black Saturday bushfires (authors' pers. obs). Marked declines have been observed in nearby forest during the dry years from 1997 to 2009 (E. McNabb pers comm.).

Eastern Grey Kangaroo *Macropus giganteus*

Populations of Eastern Grey Kangaroos seem to increase rapidly when land use changes from a predominantly farming community to a more urbanised one. This seemingly paradoxical response is probably due to the removal of active population control that was formerly undertaken by farmers, combined with reduced competition for food from livestock. The result is high populations of kangaroos in semi-rural, outer suburbs, which create significant animal wel-

fare problems, including starvation resulting from over-grazing during times of low rainfall, harassment by dogs, and collisions with vehicles. Large groups of Eastern Grey Kangaroos (>100) have caused problems of this sort in the Shire of Whittlesea in recent years. Small numbers of Eastern Grey Kangaroos have taken up residence in open woodland as close to the CBD as Heidelberg.

Koala *Phascolarctos cinereus*

Following an initial catastrophic decline in the early 20th century, the Koala has been re-introduced to most of the remaining suitable habitat in Victoria (Menkhorst 2008), including areas along the Yarra Valley within Greater Melbourne. Populations persist in parks and reserves in outer, north-eastern suburbs including Wonga Park, Warrandyte, Park Orchards and Templestowe, and on the southern Mornington Peninsula.

Grey-headed Flying-fox *Pteropus poliocephalus*

The Grey-headed Flying-fox (back cover) has been part of Melbourne's fauna since records have been kept—there are Museum Victoria specimens collected at Queenscliff in 1884. However, during the last 30 years its status in Melbourne has changed from a sporadic visitor (Menkhorst and Dixon 1985) to permanent resident (van der Ree *et al.* 2006) and one of the most abundant and visible mammal species in the region. The flying-foxes spend the daylight hours in a single extensive 'camp' along the Yarra River at Kew. Regular counts of flying-foxes as they leave the camp at dusk indicate that this camp has exceeded 40 000 individuals and has remained above 12 000 in recent years, even in mid-winter (R van der Ree unpubl. data). The southwards shift in distribution of this species, including a 750 km southward extension of its breeding range (Tidemann *et al.* 2008), and its exponential occupation of a vacant habitat niche in suburban Melbourne, is a remarkable illustration of adaptability. This distributional shift is perhaps encouraged by habitat loss and fragmentation in its former core range, but has been enabled by the creation of a tolerable climatic envelope within the metropolis of Melbourne and the provision of diverse, year-round food sources in the form of greatly increased

tree diversity in gardens and plantations across Melbourne (Williams *et al.* 2006). In 2002–03, the preferred campsite of this highly gregarious species was shifted by concerted management action from the Royal Botanic Gardens in South Yarra to a natural riparian forest along the Yarra River at Kew, where it has remained. In Melbourne, Grey-headed Flying-foxes suffer greatly during periods of hot, dry weather and considerable mortality has been recorded on days of extreme heat and drying winds. For example, on 7 February 2009 when the ambient temperature for Melbourne reached 46.4 °C (Bureau of Meteorology data), about 20% of the colony perished (van der Ree *et al.* 2009), indicating that Melbourne is, at times, outside the climatic tolerance of the species.

Australian Fur Seal *Arctocephalus pusillus doriferus*

The population of Australian Fur Seals that breeds at Seal Rocks off Phillip Island has increased in number over recent years and annual pup production is also increasing steadily (Kirkwood *et al.* 2010). Commensurate with this, mostly sub-adult individuals are making increased use of structures in Port Phillip as haul-out sites for resting. Chinaman's Hat, a former navigation structure which has been specially refurbished to provide a resting place for seals, regularly features 20 or more individuals and is the centrepiece of a small swim-with-the-seals ecotourism industry.

Sambar *Cervus unicolor*

The Sambar is by far the most successful of the deer species introduced to Victoria during the 1860s and 1870s (Menkhorst 1995c) when the acclimatisation movement had strong community support. The species now occupies most forested country in the Eastern Highlands biogeographic region and parts of the Central Victorian Uplands (VBA data). Recognising the damage that high populations of this browsing species can cause to rare vegetation communities, the Victorian Government has listed 'reduction in biodiversity of native vegetation by Sambar (*Cervus unicolor*)' as a threatening process under the Flora and Fauna Guarantee Act 1988. The species is well established in forested areas of Greater Melbourne and evidence

of increasing population densities and deleterious impacts on natural vegetation communities is of concern. Near Yellingbo, high-density Sambar populations have damaged understorey vegetation, causing opening and drying of the specialised swamp habitat of two important threatened species, Leadbeater's Possum and the Helmeted Honeyeater. They also browse shrubs and saplings planted by volunteers attempting to rehabilitate habitat for those threatened species, necessitating the construction of expensive fences around revegetation sites.

Fallow Deer *Cervus dama*

In 1995 the available information suggested that there were few feral populations of Fallow Deer in Victoria (Menkhorst 1995d) and if the species persisted in the Greater Melbourne region numbers must have been very low. That situation has changed dramatically in the ensuing 16 years, and populations are now readily apparent in parts of the urban fringe in the Shires of Nilumbik, Yarra Ranges and Cardinia, particularly where there are extensive forest-pasture boundaries. This increase may result partly from the illegal release of animals from deer farms, but may also reflect a reduction in hunting pressure that is a consequence of changing human demographics resulting from the increasing urbanisation of the outer parts of Greater Melbourne.

Humpback Whale *Megaptera novaeangliae*

The population of Humpback Whales using the east coast of Australia as a migration route to the calving grounds off Queensland has increased at about 11% per annum over the past few decades (Paterson *et al.* 1994). In line with this increase is an increased frequency of sightings of Humpback Whales in Port Phillip—sightings are now an annual event and most commonly occur in May–June, as the whales make their way north from Antarctic waters to sheltered waters inside the Great Barrier Reef. The whales do not remain long in Port Phillip, probably inadvertently passing through the Heads and taking some time to realise that it is a land-locked bay. It seems likely that individuals that move eastwards through Bass Strait, and may briefly enter Port Phillip, have travelled up the west coast of Tasmania rather than the more usual east coast route (Warneke 1995a).

Species whose current status is uncertain

Three species of small mammal have not been recorded in the survey area for many years, but their absence from the record may reflect the decline in survey effort apparent since the mid 1990s, rather than actual declines. Interesting inland records of the Swamp Antechinus from Bunyip State Park in 1981 have never been replicated. The Common Dunnart *Sminthopsis murina* was known to occur in the dry box forests of the Christmas Hills–St Andrews area until the early 1990s. There have been no records for almost 20 years and its status in the region is unknown. The Broad-toothed Rat *Mastacomys fuscus* was known from several sites in the Dandenong Ranges during the 1970s and from Bunyip State Park in 1995. Its continuing presence in the Dandenongs seems unlikely but we are hopeful that populations persist in Bunyip State Park. A small population persists at Bel-lell Creek in the far east of the study area and it is likely that other populations persist in the catchment of the Upper Yarra Dam. Systematic surveys are long overdue.

The Dingo *Canis lupus dingo* was originally found throughout the study area in all terrestrial habitats. Once attempts to establish a sheep grazing industry began it was persecuted mercilessly. Calls for a bounty began as early as June 1836 (Weidenhofer 1967 cited in Hateley (undated)). Subsequently strychnine was widely deployed as a poison and gin traps laid (Menkhorst 1995e, Hateley undated) and the Dingo was removed from all but the most densely forested areas. Wild dogs still persist in the east of the Greater Melbourne region but hybridisation with feral domestic dogs is now the major threat and whether any pure Dingos remain is moot.

Significant Species

From a conservation and public education perspective, at the State-wide scale, the Greater Melbourne region supports important populations of several species. A personal view of the significant species of the region is presented below.

Southern Brown Bandicoot *Isoodon obesulus*

Formerly widespread in the 'sandbelt' south-eastern suburbs, this species has been in a steady decline and range contraction to the

south-east for over 50 years (Menkhorst and Seebeck 1990; Coates *et al.* 2008). It now occurs in small isolated populations in remnant habitat such as at The Pines Nature Conservation Reserve at Frankston North, and along the shores of Western Port (Coates *et al.* 2008). It is the subject of a concerted community conservation campaign led by the Western Port Biosphere Foundation, which has adopted the species as an icon for its work in encouraging a sustainable society in the Western Port region. Their coordinated predator control and habitat connectivity enhancement are now achieving encouraging results (T Coates pers. comm.). The most secure populations in Greater Melbourne are in heathy forest in Bunyip State Park, in the Royal Botanic Gardens, Cranbourne, and on Quail Island offshore from Warneet. The Botanic Gardens site is one of very few places in Victoria where wild bandicoots can be readily viewed in daylight (Fig. 2).

Long-nosed Bandicoot *Perameles nasuta*

The Long-nosed Bandicoot appears to be the most resilient of the Family Peramelidae. Nevertheless, it has declined steadily in the Greater Melbourne region as urbanisation expands into its habitat in the forested ranges and along the coast. Populations persist in the foothills of the Eastern Highlands and patchily in the southern Mornington Peninsula, where it appears to be dependent upon grass/sedge swales adjacent to dense shrub cover (M Legge pers. comm.). It may not persist in long unburnt patches where Coastal Tea-tree *Leptospermum laevigatum* becomes dominant, reducing the floristic diversity of the ground layer vegetation. Where housing encroaches these habitat patches, the application of suitable ecological burning regimes is extremely difficult, threatening the continuing presence of the species. A small and isolated population also exists in coastal shrubland and grassland at North Head, Sydney (Hughes and Banks 2010), sharing some ecological and de-



Fig. 2. Southern Brown Bandicoot *Isoodon obesulus*, Royal Botanic Gardens, Cranbourne. Photo Peter Menkhorst.

mographic similarities with the Mornington Peninsula population.

Leadbeater's Possum *Gymnobelideus leadbeateri* at Yellingbo

The core range of the endangered Leadbeater's Possum is the montane ash forests of the Victorian Central Highlands, above 600 m altitude, only 70–80 km east of the Melbourne Central Business District. An isolated, lowland population of Leadbeater's Possum was discovered in 1986 in the Yellingbo Nature Conservation Reserve in very different habitat—a narrow band of remnant lowland *Eucalyptus camphora* swamp-forest (Smales 1994). This population has since been intensely studied (Harley *et al.* 2005; Harley and Lill 2007). It is now clear that the Yellingbo population is genetically distinct from those in the montane forests (Hansen and Taylor 2008). It is likely the sole remaining remnant of a population that formerly inhabited the coastal plains of Western Port, in vegetation with strong similarities to that occupied at Yellingbo, but long since drained and converted to farmland (Menkhorst and Lumsden 1995).

Grey-headed Flying-fox *Pteropus poliocephalus*
Now one of the most abundant native mammalian species in Greater Melbourne, the colonisation of Melbourne by this species is described under 'Species that have increased'. The flying-fox camp at Bellbird Picnic Area, Yarra Bend Park, is surely the greatest wildlife spectacle in the Greater Melbourne region with many thousands of individuals, and their extensive behavioural repertoire, easily observed from riverside walking tracks (back cover).

Smoky Mouse *Pseudomys fumeus*

Surveys using remotely triggered cameras have detected the endangered Smoky Mouse with encouraging regularity in the forested reaches of the Upper Yarra Shire in recent years (DSE unpublished data; Nelson *et al.* 2009). The persistence of the species in the catchment of the Upper Yarra Dam was uncertain after almost no records between 1989 and 2000 (Menkhorst and Broome 2006), but the recent records suggest that the Upper Yarra forests should be considered part of the Central Highlands stronghold of this endangered species (Fig. 3).

Water Rat *Hydromys chrysogaster*

The native Water Rat, or Rakali, is widespread in wetlands across the Greater Melbourne region and also along sheltered shorelines of Port Phillip. A population based around the breakwater at the popular St Kilda pier tourist precinct provides an opportunity for the public to observe this little-known species. The Water Rats have dens amongst the boulders forming the breakwater, and forage between there and the shore, and also make use of nearby canals bringing stormwater runoff to Port Phillip. They can be observed foraging in shallow water or along the shore, particularly around dusk when the tide is low. Water Rats also occur in artificial wetlands in inner suburbs, including those in the Royal Botanic Gardens and Fitzroy Gardens. A population at the Western Treatment Plant, south-east of Werribee, may be primarily located along the Werribee and Little Rivers, but also utilises the drains, lagoons and other wetlands of the sewage treatment plant itself (Way and Conole 2002).

Burrnan Dolphin *Tursiops australis*

Port Phillip supports a resident population of 80–100 bottlenose dolphins that have been the subject of considerable study in recent decades by the Dolphin Research Institute and by geneticists based at Monash University. These studies have focused on behaviour, distribution and population processes (Scarpaci *et al.* 2003), the impact of 'swim with the dolphins' tourism (Scarpaci *et al.* 2010), and on the taxonomic identity of the dolphins. Importantly, the Port Phillip bottlenose dolphins belong to a newly described species that also occurs in sub-populations in a few shallow embayments across southern Australia, including the Gippsland Lakes (Charlton-Robb *et al.* 2011). Based on population size alone, Port Phillip is a stronghold for this species and the Victorian population meets the IUCN criteria for Critically Endangered (DSE 2007).

Short-beaked Common Dolphin *Delphinus delphis*

Common dolphins *Delphinus* spp are often thought of as wide-ranging, oceanic species that can occur in very large herds—sometimes many thousands. Until recently the Short-



Fig. 3. Smoky Mouse *Pseudomys fumeus*, Mt Terrible. Photo Peter Menkhorst.

beaked Common Dolphin has been considered a casual visitor to Port Phillip (Warneke 1995b) with occasional sightings of small groups and strandings of individuals, e.g. 11 individual strandings in the 20 years from 1974 to 1993. In 2006, researchers from the Dolphin Research Institute became aware of a small population in eastern Port Phillip, most often sighted offshore between Mt Martha and Mornington. This population seems to be resident in eastern Port Phillip, at least in the cooler months. It appears to be an unusually isolated, inshore, and local population that warrants further study.

Discussion

The 92 species recorded for the Greater Melbourne region (Appendix 1) represent 65% of the mammalian species recorded for Victoria (PWM unpubl. data). This high level of species diversity reflects the diversity of landforms, climate, soils and vegetation which provides a rich suite of habitats.

An analysis of the survival of mammal species in the Melbourne suburbs, based on records contained in the VBA, was presented by van der Ree (2004). That analysis compared survivorship of species over time in Local Government Areas, and provided important insights into the impacts of urbanisation on Australian mammals. Our study considered a larger area by including rural or forested parts of outer LGAs, and we did not rely exclusively on VBA records—where necessary we included knowledge of species occurrence that post-dated records in the VBA. However, the results of the two studies are in general agreement, adding weight to van der Ree's (2004) conclusions including:

- Species which have remained stable or increased are typically generalists that are capable of utilising the new or altered resources available in the urban landscape.
- About one-third of terrestrial mammal species in the Melbourne region have undergone

a demonstrable decline, 10% have been lost from the region completely and the continuing presence of another four species is uncertain.

- The historical information for microchiropteran bats is insufficient confidently to demonstrate a change in distribution or status, but 17 species have been recorded in the greater Melbourne region.

Indigenous, small, ground mammals (dasyurids, bandicoots, potoroids and rodents) are most sensitive to urbanisation and, with the exception of the Water Rat, are completely excluded from urbanised Melbourne. Even in semi-urbanised areas few indigenous, small ground mammals survive—only the Brush-tailed Phascogale, Southern Brown Bandicoot, Long-nosed Bandicoot and Swamp Rat are able to eke out a precarious existence. The two most abundant small mammals in forests in the study area, the Agile Antechinus *Antechinus agilis* and Bush Rat *Rattus fuscipes*, seem unable to survive even low levels of urbanisation. Buckmaster *et al.* (2010) found that antechinus do not persist in nature reserves in Canberra, even large and relatively undisturbed ones, giving further support to this observation.

The rate of species loss documented for the Greater Melbourne region is not high in comparison to other parts of Victoria where it has been investigated, e.g. the Mallee (Bennett *et al.* 2007; Menkhorst 2009) and Gippsland (Bilney *et al.* 2010). In part, this is because the baseline data are poor, and species may have disappeared without any prior knowledge of their presence. For example, for north-western Victoria an excellent baseline mammal survey was conducted by the Blandowski Expedition of 1856–57, allowing a detailed understanding of what has been lost (Menkhorst 2009). Despite Melbourne being the centre of 19th century scientific endeavour in Victoria, including housing the headquarters of the Royal Society of Victoria and the Field Naturalists Club of Victoria, there was little documentation of its mammalian fauna during the 19th century. This lack of historical information is compounded by the lack of sub-fossil deposits in the region, including ancient, preserved castings from owls—investigation of that source of evidence allowed

Bilney *et al.* (2010) to propose a much higher level of mammal species attrition from the forests of Gippsland than had previously been realised. A similar loss may have occurred in parts of the Melbourne region but is masked by a lack of suitable sub-fossil deposits.

In Melbourne the great mammalian survivors of urbanisation are the two common possum species, flying-foxes, some insectivorous bats and the Water Rat. Up to 10 species of microchiropteran bat still occur in the Greater Melbourne region, and some, particularly Gould's Wattled Bat *Chalinolobus gouldii* and the White-striped Freetail Bat *Tadarida australis* are common in the suburbs. Other species persist in semi-urbanised areas. The Platypus *Ornithorhynchus anatinus* survives in the Yarra River within 12 km of the Central Business District, and is also present in most streams in outer suburban areas including the Plenty River, Werribee River, Diamond Creek and Gardiners Creek. The Echidna *Tachyglossus aculeatus*, Koala and Common Wombat *Vombatus ursinus* are still present in places along the Yarra Valley, as are the Eastern Grey Kangaroo and Black Wallaby *Wallabia bicolor*. There is anecdotal evidence that some of these species have increased in recent years in middle suburbs (e.g. Platypus and Common Wombat are now regularly sighted along the Yarra River near Heidelberg, and the Black Wallaby is seen there with increasing frequency). However, these species are strongly associated with 'natural' habitats and their continued presence will depend upon our ability to retain remnant native habitats in good condition, and to improve the connectivity of those remnants through retention and restoration of habitat links.

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Appendix 1.

List of mammalian species recorded from the Greater Melbourne region and the Melbourne urban area (a subset of the former), showing the number of records and year of last record in the Victorian Biodiversity Atlas (species names and sequence follow Menkhorst and Knight 2010). Victorian conservation status (DSE 2007): RX – regionally extinct; EN – endangered; VU – vulnerable; NT – near threatened; DD – data deficient. Status in Greater Melbourne: W – widespread, R – restricted; NR – no longer in the region; NV – no longer in Victoria; V – vagrant; ↓ probably declining in abundance in Greater Melbourne area; ↑ probably increasing in abundance in Greater Melbourne area. * – introduced species.

Species	Number of records in VBA		Year of last record in VBA		Victorian conservation status	Estimated status in Gr. Melb
	Greater	Urban	Greater	Urban		
Platypus	708	161	2010	2010		W
Short-beaked Echidna	821	116	2008	2007		R↓
Agile Antechinus	1381	45	2005	1995		R↓
Swamp Antechinus	3		1981		NT	NR
Dusky Antechinus	438	28	2008	1995		R↓
Spot-tailed Quoll	16	4	1994	1994	EN	R↓
Eastern Quoll	23	4	1930	1882	RX	NV
Brush-tailed Phascogale	257	8	2007	1998	VU	R↓
Fat-tailed Dunnart	93	14	1991	1991	NT	R↓
White-footed Dunnart	37	2	1985	1985	NT	NR?
Common Dunnart	44	1	1991	1991	VU	NR?
Southern Brown Bandicoot	354	92	2008	2008	NT	R↓
Eastern Barred Bandicoot	22	4	2003	1982	CE	R
Long-nosed Bandicoot	147	14	2011	1990		R↓
Common Wombat	977	25	2007	2004		R↓
Koala	2164	120	2008	2008		R
Mountain Brushtail Possum	555	4	1993	1993		R
Common Brushtail Possum	2115	914	2008	2008		W
Eastern Pygmy-possum	67	4	1992	1963	NT	R↓
Leadbeater's Possum	240		2009		EN	R↓
Sugar Glider	1030	127	2008	2007		W
Yellow-bellied Glider	573	1	1987	1980		R
Greater Glider	946	3	1992	1968		R
Common Ringtail Possum	2598	891	2008	2008		W
Feathertail Glider	222	23	1992	1988		R
Southern Bettong	3	2	1869	1869	RX	NV
Eastern Grey Kangaroo	1732	183	2008	2008		W↑
Red-bellied Pademelon		1		1881	RX	NV
Black Wallaby	1191	83	2008	2008		R
Grey-headed Flying-fox	1169	1057	2010	2010	VU	W↑
Little Red Flying-fox	10	5	2008	2008		R
Black Flying-fox	2	2	2010	2010		V
Eastern Horseshoe Bat	10		1989		VU	R↓
Yellow-bellied Sheathtail Bat	9	8	2002	2002		V
Eastern Freetail Bat	20	1	1998	1991		R
South-eastern Freetail Bat	13	5	1998	1998		R
White-striped Freetail Bat	550	98	2008	2008		W
Common Bent-wing Bat	735	9	1992	1966		R
Gould's Wattled Bat	610	115	2007	2005		W
Chocolate Wattled Bat	571	22	2007	2003		W
Eastern False Pipistrelle	118	1	2007	1987		R
Large-footed Myotis	112	1	1998	1993	NT	R
Gould's Long-eared Bat	98	2	2002	2002		R
Lesser Long-eared Bat	579	84	2007	2003		W
Inland Broad-nosed Bat	5		1988			R
Eastern Broad-nosed Bat	26	4	2002	2002		R
Large Forest Bat	503	29	2003	2003		R
Southern Forest Bat	823	8	2007	2003		W
Little Forest Bat	601	53	2003	2003		W

Appendix 1. Continued.

Species	Number of records in VBA		Year of last record in VBA		Victorian conservation status	Estimated status in Gr. Melb
	Greater	Urban	Greater	Urban		
Water Rat	250	75	2008	2008		W†
Broad-toothed Rat	56	3	1994	1982	DD	NR?
Smoky Mouse	30		2011		CE	R
New Holland Mouse	31		1983		VU	NR
Bush Rat	1639	38	2007	1960		W↓
Swamp Rat	448	53	2007	2007		W
Black Rat*	564	163	2010	2010		W
Brown Rat*	126	62	2006	2005		R
House Mouse*	1004	194	2010	2007		W
Eastern Grey Squirrel*	8	8		1935		NV
Dingo & Dog* (feral)	181	26	2005	2005		R
Red Fox*	1557	309	2007	2007		W
Ferret*	8	1	2008	1988		R
Cat*	321	86	2008	2008		W
New Zealand Fur Seal	3		1997		VU	V
Sub-antarctic Fur Seal	2		1996			V
Australian Fur Seal	45		2008			W
Leopard Seal	17		1990			R
Crabeater Seal	3		1974			V
Southern Elephant Seal	12		2006			V
Goat* (feral)	49		2004			R
Fallow Deer*	17	1	2007	1983		R†
Red Deer*	2		2003			R
Sambar*	102		2007			W†
Pig* (feral)	21		1988			R
European Rabbit*	1905	232	2008	2008		W
European Hare*	298	57	2009	2009		W
Short-beaked Common Dolphin	15		2006			R
Short-finned Pilot Whale	1		1964			V
Fraser's Dolphin	1		1978			V
Killer Whale	7		2005			R
False Killer Whale	1		1965			V
Bottlenose Dolphin sp.	103		2000			R
Southern Aust Bottlenose Dolphin	3		2010		EN	W
Southern Bottlenose Whale	1		1992			V
Sperm Whale	1		1839			V
Pygmy Sperm Whale	1		1954			V
Southern Right Whale	16		2007		CE	R
Dwarf Minke Whale	1		1999			R
Humpback Whale	25		2011		VU	W†
Totals	34197	5687				